

We claim:

1. A method for preparing chemically treated pulp fibers comprising:
 - a) creating a fiber slurry comprising process water and virgin pulp fibers;
 - b) transporting the fiber slurry to a web-forming apparatus of a pulp sheet machine and forming a wet fibrous web;
 - 5 c) drying the wet fibrous web to a predetermined consistency thereby forming a dried fibrous web; and,
 - d) treating the dried fibrous web with a water insoluble chemical additive thereby forming a chemically treated dried fibrous web containing chemically treated pulp fibers, wherein the chemically treated pulp fibers have an improved level of chemical retention of
10 the water insoluble chemical additive and retain from between about 25 to about 100 percent of the applied amount of the water insoluble chemical additive when the chemically treated pulp fibers are redispersed in water.
2. The method of Claim 1, further comprising transporting the chemically treated dried
15 fibrous web to a paper machine and mixing the chemically treated dried fibrous web with water to form a chemically treated pulp fiber slurry containing the chemically treated pulp fibers having the water insoluble chemical additive retained thereby.
3. The method of Claim 1, wherein the dried chemically treated fibrous web includes a
20 gradient of the water insoluble chemical additive.
4. The method of Claim 1, further comprising dewatering the wet fibrous web thereby forming a dewatered fibrous web.
- 25 5. The method of Claim 4, further comprising drying the dewatered fibrous web thereby forming the dried fibrous web.
6. The method of Claim 5, wherein the chemically treated dried fibrous web includes a gradient of the chemical additive.

30

- 7.** The method of Claim 2, further comprising producing a finished paper or tissue product having enhanced quality due to the retention of the water insoluble chemical additive by the chemically treated pulp fibers.
- 5 **8.** The method of Claim 1, wherein the water insoluble chemical additive is selected from the group comprising softening agents, dry strength agents, wet strength agents, opacifying agents, dyes, debonding agents, absorbency agents, sizing agents, optical brighteners, chemical tracers, and mixtures thereof.
- 10 **9.** The method of Claim 1, wherein the water insoluble chemical additive is selected from the group consisting of: mineral oil; petrolatum; olefins; alcohols; fatty alcohols; ethoxylated fatty alcohols; esters; high molecular weight carboxylic and polycarboxylic acids and their salts; polydimethylsiloxane and modified polydimethylsiloxane; and, mixtures thereof.
- 15 **10.** The method of Claim 1, further comprising creating a chemically treated pulp fiber slurry by redispersing the chemically treated dried fibrous web in water.
- 11.** The method of Claim 1, wherein the water insoluble chemical additive is applied to
20 the dried fibrous web in an amount of at least about 0.1 kilograms per metric ton or greater.
- 12.** The method of Claim 1, wherein the dried fibrous web has a consistency ranging from about 65 percent to about 100 percent.
- 25 **13.** The method of Claim 1, wherein sufficient residence time is provided after the water insoluble chemical additive is applied to the dried fibrous web to allow for retention of the water insoluble chemical additive by the chemically treated pulp fiber of the dried fibrous web.
- 30 **14.** The method of Claim 1, further comprising forming a paper or tissue product from the chemically treated dried fibrous web.

15. A paper or tissue product made using the method of Claim 1.

16. The paper or tissue product of Claim 15, wherein the amount of the water insoluble chemical additive applied to the dried fibrous web is about 0.1 kilogram per metric ton or greater.

17. A method for applying a water insoluble chemical additive to pulp fiber, the method comprising:

- a) mixing pulp fibers with process water to form a fiber slurry;
- b) transporting the fiber slurry to a web-forming apparatus of a pulp sheet machine and forming a wet fibrous web;
- c) dewatering the wet fibrous web to a predetermined consistency thereby forming a dewatered fibrous web; and,
- d) applying a water insoluble chemical additive to the dewatered fibrous web thereby forming a chemically treated dewatered fibrous web containing chemically treated pulp fibers,

wherein the chemically treated pulp fibers have an improved level of chemical retention of the water insoluble chemical additive and retain from between about 25 to about 100 percent of the applied amount of the water insoluble chemical additive when the chemically treated pulp fibers are redispersed in water.

18. The method of Claim 17, further comprising transporting the chemically treated dewatered fibrous web to a paper machine and mixing the dewatered fibrous web with water thereby forming a chemically treated pulp fiber slurry, wherein the chemically treated pulp slurry containing chemically treated pulp fibers having the water insoluble chemical additive retained thereby.

19. The method of Claim 17, wherein the chemically treated dewatered fibrous web includes a gradient of the non-watered soluble chemical additive.

20. The method of Claim 17, further comprising drying the chemically treated dewatered fibrous web to a predetermined consistency thereby forming a chemically treated dried fibrous web.

21. The method of Claim 20, wherein the chemically treated dried fibrous web includes a gradient of the water insoluble chemical additive.

5 **22.** The method of Claim 20, further comprising transporting the chemically treated dried fibrous web to a paper machine and mixing the dried fibrous web with water thereby forming a chemically treated pulp fiber slurry, wherein the chemically treated pulp slurry containing the chemically treated pulp fibers having the water insoluble chemical additive retained thereby.

10

23. The method of Claim 22, further comprising transporting the chemically treated pulp fiber slurry through the paper machine to form a finished paper or tissue product having enhanced quality due to the retention of the water insoluble chemical additive by the chemically treated pulp fibers.

15

24. The method of Claim 22, wherein the amount of the water insoluble chemical additive retained by the chemically treated pulp fibers is about 0.1 kilogram per metric ton or greater, and the amount of unretained the water insoluble chemical additive in the water is between 0 and about 50 percent of the amount of the applied water insoluble chemical additive retained by the chemically treated dried fibrous web.

25. The method of Claim 17, wherein the amount of the water insoluble chemical additive applied to the dewatered fibrous web is about 1 kilograms per metric ton or greater.

20 **26.** The method of Claim 17, wherein the amount of the water insoluble chemical additive applied to the dewatered fibrous web is about 3 kilograms per metric ton or greater.

27. The method of Claim 17, wherein the amount of the water insoluble chemical additive applied to the dewatered fibrous web is about 5 kilograms per metric ton or greater.

25

28. The method of Claim 17, wherein the water insoluble chemical additive is selected from the group comprising softening agents, dry strength agents, wet strength agents, opacifying agents, dyes, debonding agents, absorbency agents, sizing agents, optical brighteners, chemical tracers, and mixtures thereof.

5

29. The method of Claim 17, wherein the water insoluble chemical additive is selected from the group consisting of: mineral oil; petrolatum; olefins; alcohols; fatty alcohols; ethoxylated fatty alcohols; esters; high molecular weight carboxylic and polycarboxylic acids and their salts; polydimethylsiloxane and modified polydimethylsiloxane; and, mixtures thereof.

10

30. A paper or tissue product made from the chemically treated pulp fiber slurry of Claim 17.

15 **31.** A method for adding at least a first chemical additive to pulp fiber, the method comprising:

- a) mixing pulp fibers with process water thereby forming a fiber slurry;
- b) transporting the fiber slurry to a web-forming apparatus of a pulp sheet machine;
- 20 c) dewatering the fiber slurry thereby forming a crumb pulp; and,
- d) applying a water insoluble chemical additive to the crumb pulp thereby forming a chemically treated crumb pulp containing chemically treated pulp fibers, wherein the chemically treated pulp fibers have an improved level of chemical retention of the water insoluble chemical additive and retain from between about 25 to about 100
- 25 percent of the applied amount of the water insoluble chemical additive when the chemically treated pulp fibers are redispersed in water.

32. The method of Claim 31, further comprising transporting the chemically treated crumb pulp to a paper machine and mixing the chemically treated crumb pulp with water to form a chemically treated pulp fiber slurry containing the chemically treated pulp fibers having the water insoluble chemical additive retained thereby.

30

33. The method of Claim 32, further comprising transporting the chemically treated pulp fiber slurry through the paper machine to form a finished paper or tissue product having enhanced quality due to the retention of at least a first chemical additive by the chemically treated pulp fibers.

5

34. The method of Claim 31, further comprising applying a second chemical additive to the chemically treated crumb pulp.

35. A method for applying water insoluble chemical additives to pulp fiber, the method comprising:

- 10 a) creating a fiber slurry comprising process water and pulp fibers;
- b) transporting the fiber slurry to a web-forming apparatus of a pulp sheet machine and forming a wet fibrous web;
- c) dewatering the wet fibrous web to a predetermined consistency thereby forming a dewatered fibrous web;
- 15 d) applying a first water insoluble chemical additive to the dewatered fibrous web thereby forming a chemically treated dewatered fibrous web of chemically treated pulp fibers; and,
- e) applying a second water insoluble chemical additive to the chemically treated dewatered fibrous web thereby forming a dual chemically treated dewatered fibrous web
- 20 containing dual chemically treated pulp fibers,
- wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the first water insoluble chemical additive and retain from between about 25 to about 100 percent of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are redispersed in water and wherein the dual chemically
- 25 treated pulp fibers have an improved level of chemical retention of the second water insoluble chemical additive and retain from between about 25 to about 100 percent of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are redispersed in water.

36. The method of Claim 35, further comprising transporting the dual chemically treated dewatered fibrous web to a paper machine and mixing the dual chemically treated dewatered fibrous web with water to form a chemically treated pulp fiber slurry containing the dual chemically treated pulp fibers having the first and second water insoluble chemical additives retained thereby.

37. The method of Claim 35, further comprising drying the dual chemically treated dewatered fibrous web to a predetermined consistency thereby forming a dual chemically treated dried fibrous web.

38. The method of Claim 37, further comprising transporting the dual chemically treated dried fibrous web to a paper machine and mixing the dual chemically treated dried fibrous web with water to form a chemically treated pulp fiber slurry containing the dual chemically treated pulp fibers having the first and second water insoluble chemical additives retained thereby.

39. The method of Claim 35, wherein the dual chemically treated dewatered fibrous web includes a gradient of the first water insoluble chemical additive.

40. The method of Claim 35, wherein the dual chemically treated dried fibrous web includes a gradient of the first water insoluble chemical additive.

41. The method of Claim 35, wherein the dual chemically treated dewatered fibrous web includes a gradient of the second water insoluble chemical additive.

42. The method of Claim 35, wherein the dual chemically treated dried fibrous web includes a gradient of the second water insoluble chemical additive.

43. The method of Claim 38, further comprising producing a finished paper or tissue product having enhanced quality due to the retention of the first and second water insoluble chemical additives by the dual chemically treated pulp fibers.

44. The method of Claim 35, wherein the first water insoluble chemical additive is selected from the group comprising softening agents, dry strength agents, wet strength agents, opacifying agents, dyes, debonding agents, absorbency agents, sizing agents, optical brighteners, chemical tracers, and mixtures thereof.

5

45. The method of Claim 44, wherein the first water insoluble chemical additive is selected from the group consisting of: mineral oil; petrolatum; olefins; alcohols; fatty alcohols; ethoxylated fatty alcohols; esters; high molecular weight carboxylic and polycarboxylic acids and their salts; polydimethylsiloxane and modified polydimethylsiloxane; and, mixtures thereof.

10

46. The method of Claim 35, wherein the second water insoluble chemical additive is selected from the group comprising softening agents, dry strength agents, wet strength agents, opacifying agents, dyes, debonding agents, absorbency agents, sizing agents, optical brighteners, chemical tracers, and mixtures thereof.

15

47. The method of Claim 46, wherein the second water insoluble chemical additive is selected from the group consisting of: mineral oil; petrolatum; olefins; alcohols; fatty alcohols; ethoxylated fatty alcohols; esters; high molecular weight carboxylic and polycarboxylic acids and their salts; polydimethylsiloxane and modified polydimethylsiloxane; and, mixtures thereof.

20

48. The method of Claim 35, wherein the first and second water insoluble chemical additives are applied to the dewatered fibrous web simultaneously.

25

49. The method of Claim 35, wherein the first water insoluble chemical additive is applied to the dewatered fibrous web in an amount of about 0.1 kilograms per metric ton or greater.

30

50. The method of Claim 35, wherein the second water insoluble chemical additive is applied to the dewatered fibrous web in an amount of about 0.1 kilogram per metric ton or greater.

51. The method of Claim 35, wherein the dual chemically treated dried fibrous web has a consistency ranging from about 65 percent to about 100 percent.

52. The method of Claim 35, wherein sufficient residence time is provided after the first
5 water insoluble chemical additive is applied to the dewatered fibrous web to allow the first water insoluble chemical additive to be retained by the dual chemically treated pulp fiber.

53. The method of Claim 35, wherein sufficient residence time is provided after the
10 second water insoluble chemical additive is applied to the dewatered fibrous web to allow the second water insoluble chemical additive to be retained by the dual chemically treated pulp fiber.

54. A paper or tissue product made using the method of Claim 35.

55. A method for applying water insoluble chemical additives to pulp fiber, the method
15 comprising:
a) mixing pulp fibers with process water to form a fiber slurry;
b) transporting the fiber slurry to a web-forming apparatus of a pulp sheet
machine and forming a wet fibrous web;
20 c) dewatering the wet fibrous web to a predetermined consistency thereby forming a dewatered fibrous web;
d) drying the dewatered fibrous web to a predetermined consistency thereby forming a dried fibrous web; and,
e) applying a first water insoluble chemical additive to the dried fibrous web and
25 applying a second water insoluble chemical additive to the dried fibrous web thereby forming a dual chemically treated dried fibrous web containing dual chemically treated pulp fibers,
wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the first water insoluble chemical additive and retain from between about 25 to about 100
percent of the applied amount of the first water insoluble chemical additive when the dual
30 chemically treated pulp fibers are redispersed in water and wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the second water insoluble chemical additive and retain from between about 25 to about 100 percent of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are redispersed in water.

56. The method of Claim 55, wherein the dual chemically treated dried fibrous web includes a gradient of the first water insoluble chemical additive.

5 **57.** The method of Claim 55, wherein the dual chemically treated dried fibrous web includes a gradient of the second water insoluble chemical additive.

58. The method of Claim 55, further comprising transporting the dual chemically treated dried fibrous web to a paper machine and mixing the dual chemically treated dried fibrous web with water to form a chemically treated pulp fiber slurry containing the dual chemically treated pulp fibers having at least the first and second water insoluble chemical additives retained thereby.

59. The method of Claim 55, further comprising transporting the chemically treated pulp fiber slurry through the paper machine to form a finished paper or tissue product having enhanced quality due to the retention of at least the first and second water insoluble chemical additives by the dual chemically treated pulp fibers.

60. The method of Claim 58, wherein the amount of the first water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilogram per metric ton or greater, and the amount of unretained first water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are redispersed in water.

25 **61.** The method of Claim 58, wherein the amount of the second water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilogram per metric ton or greater, and the amount of unretained second water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are redispersed in water.

62. The method of Claim 58, wherein the amount of the first water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilograms per metric ton or greater, and the amount of unretained first water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are redispersed in water and wherein the amount of the second water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilogram per metric ton or greater, and the amount of unretained second water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are redispersed in water.

63. A paper or tissue product made using the method of Claim 55.

64. A method for applying water insoluble chemical additives to pulp fiber, the method comprising:

- a) mixing pulp fibers with process water to form a fiber slurry;
- b) transporting the fiber slurry to a web-forming apparatus of a pulp sheet machine and forming a wet fibrous web;
- c) dewatering the wet fibrous web to a predetermined consistency thereby forming a dewatered fibrous web;
- d) applying a first water insoluble chemical additive to the dewatered fibrous web to the dewatered fibrous web thereby forming a chemically treated dewatered fibrous web;
- e) drying the chemically treated dewatered fibrous web to a predetermined consistency thereby forming a chemically treated dried fibrous web; and,
- f) applying a second water insoluble chemical additive to the chemically treated dried fibrous web, thereby forming a dual chemically treated dried fibrous web containing dual chemically treated pulp fibers,

wherein the dual chemically treated pulp fibers have an improved level of chemical retention of the first water insoluble chemical additive wherein the level of chemical retention of the first water insoluble chemical additive is between about 25 to about 100 percent retention of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are redispersed in water and the dual chemically treated pulp fibers have an improved level of chemical retention of the second water insoluble chemical additive wherein the level of chemical retention of the second water insoluble chemical additive is

between about 25 to about 100 percent retention of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are redispersed in water.

5 **65.** The method of Claim 64, wherein the chemically treated dewatered fibrous web includes a gradient of the first water insoluble chemical additive.

66. The method of Claim 64, wherein the dual chemically treated dried fibrous web includes a gradient of the first water insoluble chemical additive.

10

67. The method of Claim 64, wherein the dual chemically treated dried fibrous web includes a gradient of the second water insoluble chemical additive.

68. The method of Claim 64, further comprising transporting the dual chemically treated
15 dried fibrous web to a paper machine and mixing the dual chemically treated dried fibrous web with water to form a chemically treated pulp fiber slurry containing the dual chemically treated pulp fibers having at least the first and second water insoluble chemical additives retained thereby.

20 **69.** The method of Claim 64, further comprising transporting the chemically treated pulp fiber slurry through the paper machine to form a finished paper or tissue product having enhanced quality due to the retention of at least the first and second water insoluble chemical additives by the dual chemically treated pulp fibers.

25 **70.** The method of Claim 68, wherein the amount of the first water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilogram per metric ton or greater, and the amount of unretained first water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are redispersed in water.

30

71. The method of Claim 68, wherein the amount of the second water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilogram per metric ton or greater, and the amount of unretained second water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are redispersed in water.

72. The method of Claim 68, wherein the amount of the first water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilograms per metric ton or greater, and the amount of unretained first water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the first water insoluble chemical additive when the dual chemically treated pulp fibers are redispersed in water and wherein the amount of the second water insoluble chemical additive retained by the dual chemically treated pulp fibers is about 0.1 kilogram per metric ton or greater, and the amount of unretained second water insoluble chemical additive in the water is between 0 and about 75 percent of the applied amount of the second water insoluble chemical additive when the dual chemically treated pulp fibers are redispersed in water.

73. A paper or tissue product made using the method of Claim 64.